



MASTER THESIS OFFER OF CEPLAS

(FOR COMPUTATIONAL MASTER STUDENTS FROM TECHNICAL UNIVERSITY OF MADRID, UPM)

Title of Master Thesis

Machine learning driven co-expression analysis of large-scale plant-fungal transcriptomic data

Description of student's tasks

At team Zuccaro we study the molecular interaction of plant roots with beneficial endophytic fungi of the order Sebaciniales which have a broad host range and with detrimental pathogens, such as *Bipolaris sorokiniana*, the causal agent of spot blotch and common root rot. Effector proteins are used by plant-associated fungi to facilitate colonization via effector triggered susceptibility and manipulation of host defense and metabolism. Past research has focused on the identification and functional characterization of effectors from pathogenic fungi during colonization of a single plant host species. **The goal of this project is to understand how beneficial and detrimental fungi regulate the expression of effector genes and their function in different plant hosts and in response to other microbes.**

For this, transcriptome maps of two beneficial fungi growing in contrasting environments (using gnotobiotic systems) during plant colonization and in confrontation with a plant pathogenic fungus or bacterial synthetic communities will be analysed. Orthologous groups will be identified and co-expressed genes analysed focusing on innovative machine learning, dimension reduction, and creative data visualization.

This work will be performed under the supervision of Prof. Dr. Alga Zuccaro (<https://www.ceplas.eu/en/research/research-area-2/> and <https://ag-zuccaro.botanik.uni-koeln.de/>), Dr. Gregor Langen and Dr. Shingo Miyachi (UoC and MPI Cologne). This project is part of an active cooperation with the DOE Joint Genome Institute (JGI) USA in the frame of the approved proposal FY20 "How Beneficial Fungi Regulate Effector Gene Expression" <https://jgi.doe.gov/csp-2020-beneficial-fungi-regulate-effector-gene-expression/>.

References

- Sarkar, D et al. (2019) The inconspicuous gatekeeper: endophytic *Serendipita vermifera* acts as extended plant protection barrier in the rhizosphere. *New Phytologist* doi: 10.1111/nph.15904.
- Nizam S, et al. (2019) *Serendipita indica* E5'NT modulates extracellular nucleotide levels in the plant apoplast and affects fungal colonization. *EMBO Rep.* 20(2). pii: e47430. doi: 10.15252/embr.201847430.
- Miyachi, S. et al. (2017) The integrative omics of white-rot fungus *Pycnoporus coccineus* reveals co-regulated CAZymes for orchestrated lignocellulose breakdown. *PLoS One* 1, 1–17.
- Fesel PH, Zuccaro A (2016). Dissecting endophytic lifestyle along the parasitism/mutualism continuum in Arabidopsis. *Curr Opin Microbiol.* 32: 103-112.
- Lahrman, U. et al. (2015) Mutualistic root endophytism is not associated with the reduction of saprotrophic traits and requires a noncompromised plant innate immunity. *New Phytologist* 207(3): 841-857.
- Zuccaro A, Lahrman U, Langen G (2014). Broad compatibility in fungal root symbioses. *Curr Opin Plant Biol.* 20: 135-145.
- Lahrman U, et al (2013) Host-related metabolic cues affect colonization strategies of a root endophyte. *Proc Natl Acad Sci. U S A.* 110(34): 13965-13970.

Prerequisites (languages, informatics skills, bioinformatic skills, other knowledge, etc)

R, Linux and programming skills required, preferentially in Python.
Genuine interest in plant microbe interactions and microbiome studies is advantageous.
It is expected that the student is fluent in English.

Training Project

EXTERNAL PRACTICES/MASTER THESIS. The fundamental goal of the external practices is to guide the student in applying his previously acquired knowledge to real tasks in a group work environment the realistically represents the work conditions the students will encounter in their future roles. In this way, the student will be able to get familiar with a working environment (work schedule, responsibility, attitude, organization, etc.), and with the adequate working methodology in professional reality, contrasting and applying the acquired academic knowledge.

Activities that will be performed in the academic internship/Master Thesis:

We will explore complex plant-microbe and microbe-microbe interactions at plant and fungal transcriptomic level using data science approaches. Due to the high complexity of multi-comparative data, we are looking to perform co-expressed gene analysis focusing on innovative machine learning, dimension reduction, and creative data visualization.
You will learn how to apply data science to handle complex real biological data generated from laboratory experiments. **You will explore data integration and visualization of genomic and transcriptomic data for plant-microbe interactions.** Through this project you will first compile a synthetic test dataset, **explore and optimize machine learning techniques**, clean gene count tables from the mapping process, do quality assessment of RNA-seq data, combine the gene annotation information for genomes, **interpret results in biological context**, and **write analytical reports**.
As a member of the Institute and CEPLAS you will have the opportunity to attend a journal club, weekly group seminars and CEPLAS meetings and offered courses at the UoC. You will present your progress on a regular basis and will give presentations during the group seminars.

Nº of positions offered:	1
Has the student dealings with underage persons?	NO
Starting date:	01/02/2021 preferred but flexible
End date:	Flexible
Weekly hours (only for internship in CEPLAS lab):	Flexible
Working hours (only for internship in CEPLAS lab):	Flexible

Fellowship (<i>if any, NOT REQUIRED</i>): Remuneration (€/month):	We request a UPM fellowship for the student for the visiting time to cover travel expenses and housing. We will cover project expenses and if the student performs the internship / Master Project in Cologne some remuneration will be provided.
Academic tutor (UPM/CBGP): <i>(you need a Tutor from UPM Master, not involved in the research activity)</i> Email:	
Department/Research Group of UPM/CBGP Academic tutor:	
CEPLAS Internship/Master Thesis Tutor/Director:	Prof. Alga Zuccaro (UoC)
Email CEPLAS tutor:	azuccaro@uni-koeln.de
Department CEPLAS tutor:	Institute for Plant Sciences, University of Cologne
Location of the internship (telecommuting?):	Telecommuting possible, but visiting Cologne and working with experimental colleagues at the UoC and MPI would be preferred for at least some of the internship.
CEPLAS Institution:	University of Cologne
To be completed by Internship Office ETSIAAB-UPM: Number of ECTS (Nº ECTS):	

Send by email to: international.cbgp@upm.es (Pablo Gómez)